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# Improving Nutritional Security of India Through a Potential Underutilized Legume-Bambara Groundnut (*Vigna subterranea* (L.) Verdc.)

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**Abstract** Neglected and underutilzed crops could play prominent roles in sustaining the impoverished rural populations by increasing their available food and protein basket and one such important underutilized crop is Bambara groundnut. In Africa, Bambara groundnut is the third most important legume after groundut and cowpea. Its seed is rich in protein containing high lysine and methionine and is considered as a balanced food compared to all other legumes. The present study was carried out duing *kharif* season of 2014-15. Bambara groundnut varieties SB-42, Uniswa Red, S-165-A, S-193 and nine isolated gamma irradiated stabilized mutants of SB-42 were used for estimation of moisture, protein, fat, ash and carbohydrates estimation.Whereas for mineral estimation,only widely adapted variety SB-42 was used in the track of Karnataka. Increased protein *per cent* was observed in all the mutants compared to its control SB-42. Mutant 11 was isolated with highest protein content as well as highest yield (28.96 g/plant). Hence there is a possibility that protein content can be increased through induced mutagenesis. The mineral composition estimated in SB-42 indicated the presence of calcium to be 260 mg/100 g and potassium 1723.25 mg/100g. While iron content was estimated to be 3.6 mg/100 g. Estimation of sodium indicated a value of 75.25 mg/100 g. By supplementing a healthy diet with potassium rich like Bambara groundnut having 1723.25 mg/100 g, patient sufferers from diabetes may improve their sensitivity to insulin, and the effctiveness of hormone. Crop has a combination of low sodium and high potassium which our studies indicated a value of protective sodium to potassium ratio (less than one) that is 0.04 significantly decreases risk of CVD (cardiovascular disease) and all-cause mortality.

**Keywords** Underutilized crop, Protein, Fat, Ash, Mineral.

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## Introduction

Plant proteins provide nearly 65% of the world supply of protein for humans; 45-50% cereals and 10-15% legumes. Legumes serve as a source of non-processed protein for rural an urban dwellers of the population especially in the poor countries of the would and as a good source of fiber, resistant starch, and other nutrients, they are one of the least glycaemic sources of carbohydrates, because the starch is eiter slowly absorbed or resistant. In view of world food shortages, it becomes expedient to harnss proteins from all available food sources to minimise food and nutritional crises. However, neglected and underutilized crops could play prominent roles in sustaining the impoverished rural populations by increasing their available food and protein basket and one such important underutilized crop as Bambara groundnut. Its seed is rich in protein containing high lysine and methionine and is considered as a balanced food compared to all other legumes. The essential amino acid content of Bambara groundnut such as lysine 6.82g/16gN, methionine 1.85g/16gN and cysteine 1.24g/16gN is comparable to that of soyabean (6.24g/16gN lysine, 1.14g/16gN methionine and 1.80g/16gN cysteine). The gross energy value of Bambara groundnut seed is greater than that of other common pulses such as cowpea, lentil and pigeon pea. It is also richer than groundnut in essential amino acids such as isoleucine, leucine, lysine, methionine, phenylalanine, threonine and valine [1].

## Materials and Methods

The present study was carried out at K-block, University of Agriculture Sciences, GKVK, Bengaluru during *kharif* season of 2014-15, located at an altitude of 899 m above Mean Sea Level and at $13.00^0$N latitude and $77.35^0$E longitude. The variety SB-42 treated with gamma rays grown in 2010, $M_1$ generation were raised and from $M_2$ generation selection was carried out based on economic characters [2]. These selected mutants advanced in plant to progeny rows till $M_6$ generation [3]. For the present investigation 9 stabilized mutants were selected from $M_6$ population based on Yield (more than SB-42) and four varieties which were procured from Junagadh were used. Bambara groundnut varieties SB-42, Uniswa Red, S-165-A, S-193 and nine isolated gamma irradiated stabilized mutants of SB-42 were used for estimation of moisture, protein, fat, ash and carbohydrates estimation. Whereas for mineral estimation only widely adapted variety in the track of Karnataka, SB-42 was used. The seeds were obtained from National Research Center on Groundnut,.Junagadh through National Bureau of Plant Genetic Resources. Seeds were sown in two replication with spacing of 30 cm between rows and 15 cm between plant to plant within a row. N: P: K fertilizers dose of 25:75:38 kg per hectare applied. Suitable management practices were undertaken during the period of the crop. Estimation method for different trait is following.

Estimation of moisture [4]

$$\text{Moisture content (g/100g)} = \frac{\text{Initial weight (g)} - \text{Final weight (g)}}{\text{Weight of the sample}} \times 100$$

Estimation of protein [4]

The protein content of the dried samples was estimated as per cent total nitrogen by the Micro-kjeldahl procedure. Protein per cent was calculated by multiplying the per cent nitrogen by the factor 6.25.

$$\text{Per cent nitrogen (\%N)} = (V_a - V_b) \times 0.0014 \times \frac{V_1}{V_2} \times \frac{100}{W}$$

Where : $V_a$ = Titre value of sample, $V_b$ = Titre value of blank, $V_1$=Volume to which digested sample was made up to 100 ml, $V_2$ = Volume to aliquot used in distillation.

$$\text{Per cent protein} = \frac{\text{Titer value} \times \text{Normality of HCL} \times 14.001 \times 6.25}{\text{Sample weight (g)}} \times 100$$

Estimation of fat [4]

Fat was estimated as crude ether extract using moisture free sample. The solvent was removed by evaporation and the residue of fat was weighed.

$$\text{Per cent Fat content (g/100g)} = \frac{\text{Weights of the ether extract (g)}}{\text{Weight of the sample taken (g)}} \times 100$$

Estimation of total ash [4]

This was expressed as g/100g of the sample.

Calculation

Weight of the crucible – W g
Weight of the crucible + sample – W1 g
Weight of the crucible + ash – W2 g
Weight of sample (W1 – W) g
Weight of the ash (W2 – W) g

$$\% \text{ Total ash} = \frac{(W2 - W)\ g}{(W1 - W)\ g} \times 100$$

$$\text{Ash content (g/100g)} = \frac{\text{Weight of the ash}}{\text{Weight of the sample}} \times 100$$

Computation of carbohydrate [4]

Carbohydrate content was calculated by differential method.

Carbohydrate (g/100g) = 100 – [Protein (g) + Fat (g) + Fiber (g) + Ash (g) + moisture (g)]

Estimation of (mineral content) calcium, iron, copper, zinc, manganese, potassium, sodium and phosporus

Mineral solution was prepared from the ash of SB-42 variety of Bambara groundnut and were fed to the AAS (Atomic Absorption Spectrophotometer) having appropriate hallow cathode lamps.

## Results and Discussion

Nutritional analysis of different varieties and isolated mutants of Bambara groundnut for moisture content, fat, ash and total carbohydrates

Bambara groundnut genotypes have exhibited non-significant variation for moisture content, fat, ash and total carbohydrates, however comparative study on the estimation of soluble seed protein content and seed yield in Bambara groundnut genotypes revealed significant variation at $p < 0.01$ with cv of 5.94% and 11.57% respectively. Data pertaining to protein content is presented in Table 1. From data, sufficient variability was observed for protein content and higher protein content was observed in mutants (19.35-24.97) compared to control (19.25). Highest protein content

**Table 1.** Nutritional composition of Bambara groundnut seeds. **Significance at 1% level,*significance at 5% level. Carbohydrate calculated by difference method.

| Sl. No. | Genotypes | Moisture (g/100 g) | Protein (g/100 g) | Fat (g/ 100 g) | Ash (g/ 100 g) | Carbohydrate (g/100 g) | Sed yield (g/plant) |
|---|---|---|---|---|---|---|---|
| 1 | SB-42 | 8.75 | 19.25 | 6.77 | 3.12 | 62.11 | 20.54 |
| 2 | Uniswa Red | 9.17 | 17 | 7.08 | 3.83 | 62.93 | 14.45 |
| 3 | S-165 A | 8.78 | 18.25 | 6.5 | 3.67 | 62.8 | 14.83 |
| 4 | S-193 | 7.75 | 18.58 | 6.49 | 6.15 | 61.02 | 11.73 |
| 5 | Mutant 1 | 7 | 19.35 | 7.35 | 4.12 | 62.18 | 17.85 |
| 6 | Mutant 2 | 8.94 | 22.37 | 6.21 | 3.88 | 58.6 | 15.3 |
| 7 | Mutant 4 | 6.92 | 22.6 | 7.37 | 4 | 59.1 | 13.41 |
| 8 | Mutant 6 | 7.44 | 20.79 | 5.75 | 5.11 | 60.9 | 18.56 |
| 9 | Mutant 8 | 8.18 | 21.21 | 7.1 | 4.11 | 59.4 | 17.61 |
| 10 | Mutant 11 | 7.24 | 24.97 | 6 | 3.66 | 58.13 | 28.96 |
| 11 | Mutant 15 | 7.75 | 21.86 | 7.4 | 3.99 | 58.99 | 22.42 |
| 12 | Mutant 19 | 9.2 | 23.15 | 7.5 | 3.34 | 56.82 | 20.62 |
| 13 | Mutant 24 | 7.24 | 21.99 | 6.95 | 3.75 | 60.07 | 18.26 |
| | Minimum | 6.92 | 17 | 5.75 | 3.12 | 56.82 | 11.73 |
| | Maximum | 9.2 | 24.97 | 7.5 | 6.15 | 62.93 | 28.96 |
| | Mean | 8.03 | 20.87 | 6.81 | 4.13 | 60.19 | 18.04 |
| | CV | 11.98 | 5.94 | 8.53 | 33.86 | 3.17 | 11.57 |
| | CD (0.05) | - | 2.7 | - | - | - | 4.55 |
| | *F* test | NS | 6.69** | NS | NS | NS | 9.33** |

was recorded in mutant 11 (24.97) with highest yield of 28.96 g/plant and minimum protein content was recorded in Uniswa Red (17.00). Hence there is a possibility that protein content can be increased through induced mutagenesis. Results of Imran et al. [5] in mung bean and Arulbalachandran et al. [6] in black gram are in confirmation with the present study. Since the total soluble protein was extracted at neutral PH, it is possible to isolate a higher total soluble seed protein when extracted at acidic and alkaline PH also. Protein malnutrition is being one of the worst curses to Indian population, identification of high protein and high yielding mutants of Bambara groundnut will serve as national food security crop to the semi-arid tracts of Indian subcontinent.

Minerals composition in SB-42 variety of Bambara groundnut

Estimation of minerals from Bambara groundnut seed has been done exclusively for SB-42 variety because it is a highly adapted variety to the local soils of Karnataka. Minerals composition has been represented in Table 2. Calcium was found to be 260 mg/100g, potassium 1723.25 mg/100g, sodium 75.25 mg/100g and iron 3.6 mg/100g which represent the nutritional importance of Bambara groundnut. Sodium to potassium ratio found to be 0.04 and calcium to phosphorous ratio is 1.72. The mineral composition estimated in SB-42 indicated the presence of calcium to be 260 mg/100g and potassium 1723.25 mg/100g. Similar report has been reported by Ijarotimi and Esho [7] in Bambara groundnut. While iron content was estimated to be 3.6 mg/100 g, Estimation of sodium indicated a value of 75.25 mg/100g. Potassium is an essential mineral micronutrient and is the main intracellular ion for all types of cells. It is important in maintaining fluid and electrolyte balance in the bodies of humans and animals. Administering insulin to the body, the treatment regime employed by many diabetics, which may cause a potassium deficiency. By supplementing a healthy diet with potassium rich like Bambara groundnut having 1723.25 mg/100g, sufferers from diabetes may improve their sensitivity to insulin, and the effectiveness of hormone. Too much sodium and too little potassium is a health risk [8]. However the crop has a combination of low sodium and high potassium which our studies indicated a value of protective sodium to potassium ratio (less than one) that is 0.04 significantly decreases risk of CVD (cardiovascular disease) and all-cause mortality.

**Table 2.** Mineral composition of Bambara groundnut variety SB-42. *Alayande et al. [9].

| Sl. No. | Minerals | Estimated quantity (mg/100g) | Reference quantity of cowpea (mg/100g) |
|---|---|---|---|
| 1. | Ca | 260 | 182.01 |
| 2. | P | 150.73 | 510.00 |
| 3. | K | 1723.25 | 768.05 |
| 4. | Mn | 1.4 | 14.27 |
| 5. | Na | 75.25 | 78.15 |
| 6. | Fe | 3.6 | 5.66 |
| 7. | Cu | 0.7 | 0.60 |
| 8. | Zn | 2.2 | 5.66 |
| 9. | Na/K ratio | 0.04 | 0.10 |
| 10. | Ca/P ratio | 1.72 | 0.35 |

## Conclusion

Bambara groundnut is neglected and underutilized crop which play prominent roles in sustaining the impoverished rural population by increasing their available food and protein basket. Protein malnutrition is being one of the worst curses to Indian population, identification of high protein and high yielding mutants of Bambara groundnut like Mutant 11 will serve as national food security crop to the semi-arid tracts of Indian subcontinent [9]. By supplementing a healthy diet with potassium rich like Bambara groundnut having 1723.25 mg/100 g, sufferers from diabetes may improve their sensitivity to insulin, and the effectiveness of hormone. Crop has a combination of low sodium and high potassium indicated a value of protective sodium to potassium ratio (less than one) that is 0.04 significantly decreases risk of cardiovascular disease and all-cause mortality.

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